Forest Health and Adaptation in Alberta

Annual Report

2013

Alberta Government

2013 Annual Report
Forest Health and Adaptation
Environment and Sustainable Resource Development

Forest Health and Adaptation Vision

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Duncan MacDonnell (Public Affairs Officer) reviewed the final draft of this report. Gwen Edge (Graphic Designer, ESRD Communications) formatted, designed and published the report.

The Forest Health and Adaptation staff gratefully acknowledge support provided by the multiple individuals, agencies, municipalities and forest companies that helped with the successful completion of the 2013 Forest Health and Adaptation Program.

Executive Summary

This is the 2013 annual report of the Forest Health and Adaptation program of the Forestry and Emergency Response Division of Environment and Sustainable Resource Development. This report contains details of detection, monitoring, assessment and management of forest health damaging agents that affected the forested Crown land in the Green Area of Alberta, and related programs carried out in 2013. It also summarises details on seed research findings, seed collections, plant propagation and genetic trial measurements.

In 2013, the mountain pine beetle, eastern spruce budworm, aspen defoliators, forest pathogens and damage caused by abiotic agents affected forest trees in the Green Area. In addition, invasive plant species threatened biodiversity of the forested Crown land. Also described here are other forest health and adaptation-related programs.

The mountain pine beetle, *Dendroctonus ponderosea*, was the main forest health damaging agent in Alberta in 2013. In the 2012 'beetle-year' reported here, long distance dispersal monitoring did not indicate influx of beetles into the province from British Columbia. There was, however, an expansion of mountain pine beetle to the north into the Northwest Territories and east towards the Saskatchewan border. Heli-GPS surveyors detected nearly 139,372 pines symptomatic of beetle-infested trees in 2012. In most areas the number of trees detected declined from previous years except its extension to the east. The green: red survey results indicated decreasing beetle populations in the Upper Athabasca Region and increasing beetle populations in the Upper Peace Region. Ground surveyors detected 98,762 high risk green attack pines for treatment. During treatments, all of beetle-infested high risk green attack trees were removed. The r-values in spring of 2013 indicated an increase in beetle success from 2012. The Mountain Pine Beetle Reforestation Seed Inventory Enhancement and Conservation Program collected 3,687 kg of lodgepole pine seed in 2012/13 and was completed by 8 agencies for 19 seed zones in Alberta.

Defoliation caused by eastern spruce budworm, *Choristoneura fumiferana*, defoliations in 2013 was confined to northern Alberta. The budworm-defoliated area remained relatively low at about 37,196 net hectares. There was no severe defoliation in 2013, only moderate. Forecasting through the use of pheromone traps will no longer be completed on a yearly basis but as determined necessary when defoliation increases and management is intensified.

The western spruce budworm, *Choristoneura occidentalis*, populations in southwest Alberta collapsed in 2012. Consequently, there was no aerially visible defoliation caused by this agent.

In 2013, the gross area of aspen defoliated by forest health damaging agents increased ten-fold, compared to that observed in 2012, to reach 6,215,218 hectares. The forest tent caterpillar, *Malacosoma disstria*, and aspen twoleaf tier, *Enargia decolor*, caused almost all of aspen defoliation in 2013 but large aspen tortrix, *Choristoneura conflictana*, and Bruce spanworm, *Operophtera bruceata*, defoliation also occurred.

The red ring blight of pine, *Dothistroma septospora*, was confirmed on high value pines growing at the Alberta Tree Improvement and Seed Centre (ATISC) as well as in a pine species-provenance trial at the Calling Lake Genetics Experimental Area. In order to manage the damage caused by this agent the infected trees in the ATISC pine clone bank were sprayed with Bordeaux, a fungicide, to reduce infection and ultimately loss of clones. Another needle blight, *Rhabdocline pseudotsugae*, was confirmed in a provenance trial at Diamond Hills on Douglas-fir. There was a noted increase of pathogen outbreaks across the province in 2013.

Compared to the impact caused by abiotic forest health damaging agents in 2012, there were fewer incidences caused by these agents in 2013. Among the abiotic agents affecting forest trees in 2013 were aspen dieback, blowdown, drought, hail, red belt and flooding. However, the extent of forested land affected by these agents was much lower than the extent of forested land affected by these agents in 2011 or 2012.

In 2013, the Alberta Tree and Seed Improvement Centre (ATISC) programs were very successful. The seed science program improved seed collection, germination and storage methods. 2013 was a record cone crop year, it is not yet known how much seed was collected but the statistics will be published in the 2014 annual report. Two hundred and eighty two new seedlots were collected in 2013, some of which included shrubs. 729 kg of seed was withdrawn and five new genetics trials were established in the province.

Forest Health crews surveyed selected locations in the Green Area of the province to detect and monitor occurrence of invasive plant species. Among the invasive plant species found during these surveys were four prohibitive noxious species. This year hawkweeds, some of which are prohibitive noxious weeds, posed serious management issues in the management of invasive plant species in the province. In 2012, ecological, mechanical and herbicidal treatments were used to manage invasive plant species. The Annual Athabasca weed workshop was the highlight of several programs conducted to increase invasive plant awareness of stakeholders.

Collaborative programs reported here include:

- the 'Climate Impact on the Productivity and Health of Aspen' plots,
- the mountain pine beetle Spread Management Action Collaborative,
- the Terrestrial Environment Effect Monitoring Team of the Wood Buffalo Environmental Association,
- the Canadian Food and Inspection Agency gypsy moths trap deployment,
- the whitebark- and limber pine recovery plan, and
- other programs to increase forest health awareness.

Introduction

This is a report on programs carried out by the Forest Health and Adaptation program of the Forestry and Emergency Response Division of Alberta Environment and Sustainable Resource Development (ESRD) in 2013. In September 2013 the Forest Health and the Alberta Tree Improvement and Seed Centre joined to become the Forest Health and Adaptation Section. This union was one of common interest, goals and a compliment of strengths; Daniel Lux will be heading up this new Section.

This report will address the many programs that make up Forest Health and Adaptation and the alterations made to incorporate a more adaptive and encompassing approach to forest health and adaptation.

This report contains details of the following:

1. The mountain pine beetle (MPB) management program including results of surveys carried out by using aggregation pheromone-baited trees to detect long-distance aerial dispersal, results of aerial surveys and aerial photography carried out to detect pine trees with red crowns symptomatic of MPB attack, results of ground surveys to detect population trends, beetle-focussed level-1 single tree treatment and the MPB reforestation seed inventory enhancement program.
2. The historical aspects, spatial distribution of defoliation, population trends and, the extent and severity of damage caused by the eastern spruce budworm as well as other conifer defoliators detected across the province.
3. The spatial distribution, extent and severity of damage caused by major aspen defoliators.
4. Forest pathogen incidence and management including red ring needle blight and Rhabdocline needle blight.
5. The spatial distribution and severity of damage due to abiotic forest tree damaging agents.
6. The invasive plants program including steps taken to increase awareness, ground surveys, and management programs carried out at selected sites in the Green Area.
7. Summary of programs specific to the Alberta Tree Improvement and Seed Centre (ATISC) including seed science, seed collections, tree improvement trials and plant propagation statistics.
8. Forest health and adaptation -related collaborative programs carried out in cooperation with other agencies, and
9. Processes used to increase forest health awareness.

Forest pest-related data are reported on a regional basis. Appendix I shows the ESRD regions and corporate areas in Alberta, in 2012.

The surveys reported in this document were carried out for operational purposes over forested Crown land over the Green Area of Alberta.

These surveys do not necessarily cover the entire forested land base. Although every effort is made to ensure accuracy and completeness of this report, its integrity is not guaranteed by ESRD.

Forest Health Damaging Agent Conditions and Management Programs in 2013

Bark Beetles

Mountain Pine Beetle, *Dendroctonus ponderosae*

Introduction

The details of the MPB management program reported here cover the 2012 beetle-year from August 15, 2012 to August 14, 2013. This period coincides with MPB dispersal from host trees in the summer of 2012 followed by the completion of the life cycle and the emergence of adult beetles in the summer of 2013.

This report covers historical aspects of the current MPB outbreak and details of the following activities:

- Detection and assessment of 2012 MPB infestations
- Actions taken to manage these infestations
- Ground surveys carried out to forecast 2013/14 MPB population trends.

The objectives, principles and actions of Alberta's mountain pine beetle program are outlined in the Mountain Pine Beetle Management Strategy that can be found at the following link: (http://mpb.alberta.ca/AlbertasStrategy/documents/MPB_man_strategy.pdf).

Detection and Assessment of MPB Infestations

Long-Distance Dispersal Monitoring

Plots containing MPB aggregate pheromones were dispersed in pre-selected townships to determine beetle presence. These plot findings cannot be used to estimate population size. Traps were placed in highly susceptible stands in June 2012 and checked for the presence of MPB in September 2012.

Figure 1 shows the results of long-distance dispersal monitoring of MPB in 2012. Plots were placed in the northwest corner of the province and north of the border to detect beetle presence in collaboration with the Northwest Territories. Positive attacks were established at these sites indicating that beetles are present all way to the border of the Northwest Territories. In collaboration with Saskatchewan the bait program was expanded east and a positive attack site was located 50 km from the Saskatchewan border indicating that MPB is moving eastward.

Figure 1. Results of pheromone-based long-distance dispersal monitoring of MPB from 2012 in Alberta.

Heli-GPS Surveys

From August 15 through September 15, 2012 heli-GPS surveyors recorded locations of pine trees with red crowns symptomatic of MPB infestations. These surveys covered areas that were determined as priorities for beetle control. Figure 2 shows where red crown pines were found within the designated areas for control practices. Heli-GPS surveys do not cover the same areas from year to year. Figure 3 shows where heli-GPS occurred.

The heli-GPS surveys detected 139,372 red trees suspected to have been killed by MPB in the areas slated for control. In most areas surveyed by heli-GPS the number of trees detected declined from 2011, apart from the eastern edge where beetles were found further east than previous years.

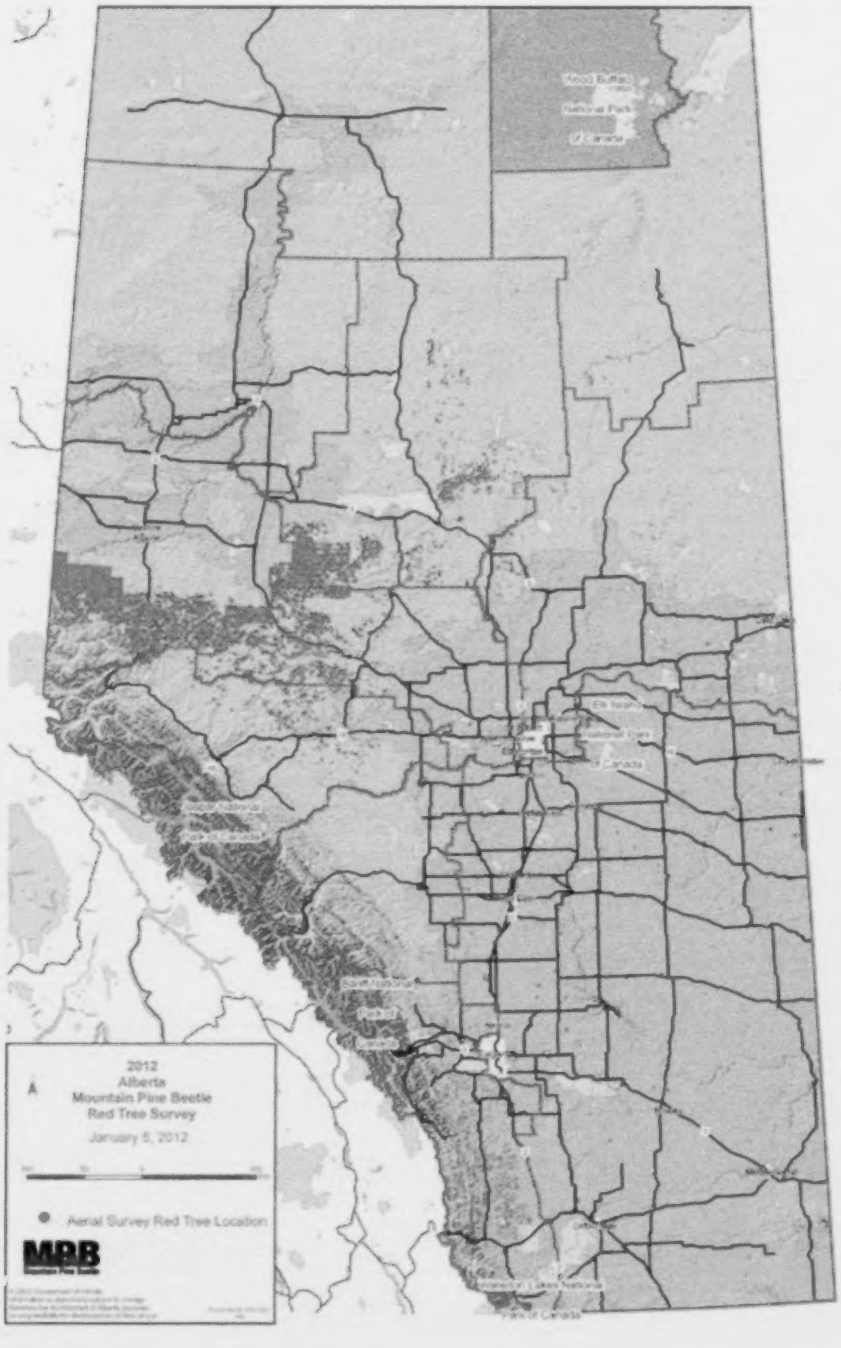
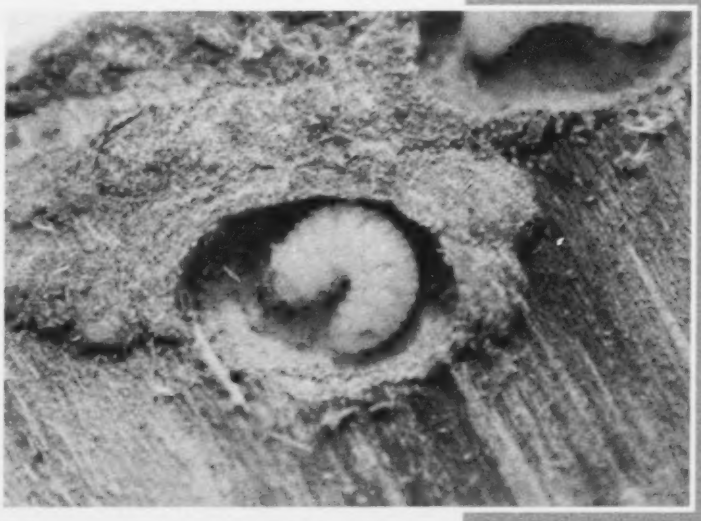


Figure 2. Results of heli-GPS aerial surveys and aerial photography carried out over pre-selected areas in 2012 fall (Note: all MPB-infested forest areas were not surveyed during heli-GPS surveys).

Figure 3. MPB heli-GPS track log for 2012 aerial surveys.

Green: Red Ratios

The green: red ratios are the ratios of green attacks (trees with current year attacks still retaining green crowns) to red attacks (trees with red crowns attacked in the previous year). This ratio indicates the relative success of beetle populations and potential for their spread.



Mature mountain pine beetle larvae

The green: red ratio surveys were carried out in early fall of 2012 at 177 sites and included 1,091 trees across the province. The results of these surveys are shown in Figure 4. These results indicate that beetle populations are decreasing in the Upper Athabasca Region but increasing in the Upper Peace Region in west-central Alberta. Results indicate a moderate to extremely high success rate of beetles in some areas near Whitecourt, Fox Creek, Edson, and north of Peace River (Figure 4). An increasing beetle population was expected in these areas. Alternatively, in the Grande Cache, Slave Lake, and some areas south of Grande Prairie, the beetles exhibited low success and the number of infested trees was expected to decline. In southern Alberta, local beetle populations have remained low since 2010, thanks to aggressive control efforts and a cold winter in 2009.

Ground Surveys to Detect Green Attacks

Ground surveys were carried out at 9,721 sites in the fall of 2012 to detect high risk green attack trees for control in the Leading-Edge and the Active Holding zones. These surveys were based on locations of red attack trees that were detected during heli-GPS surveys. Altogether, ground surveyors detected 98,762 high risk green attack trees that were earmarked for control.

Infested-Tree Treatment Under the MPB Management Program

A Decision Support System (DSS) supported by the geographic information system is used to prioritize sites with MPB-infested trees for survey and control. The DSS categorizes beetle-infested sites detected by heli-GPS surveys into five categories of MPB spread risk, varying from very low to extreme, based on beetle biology and stand characteristics. The goal is to survey and control trees at 80 per cent or more of the sites that are ranked as having moderate, high or extreme risk of spread within the Leading-Edge and Active Holding zones (Figure 5).

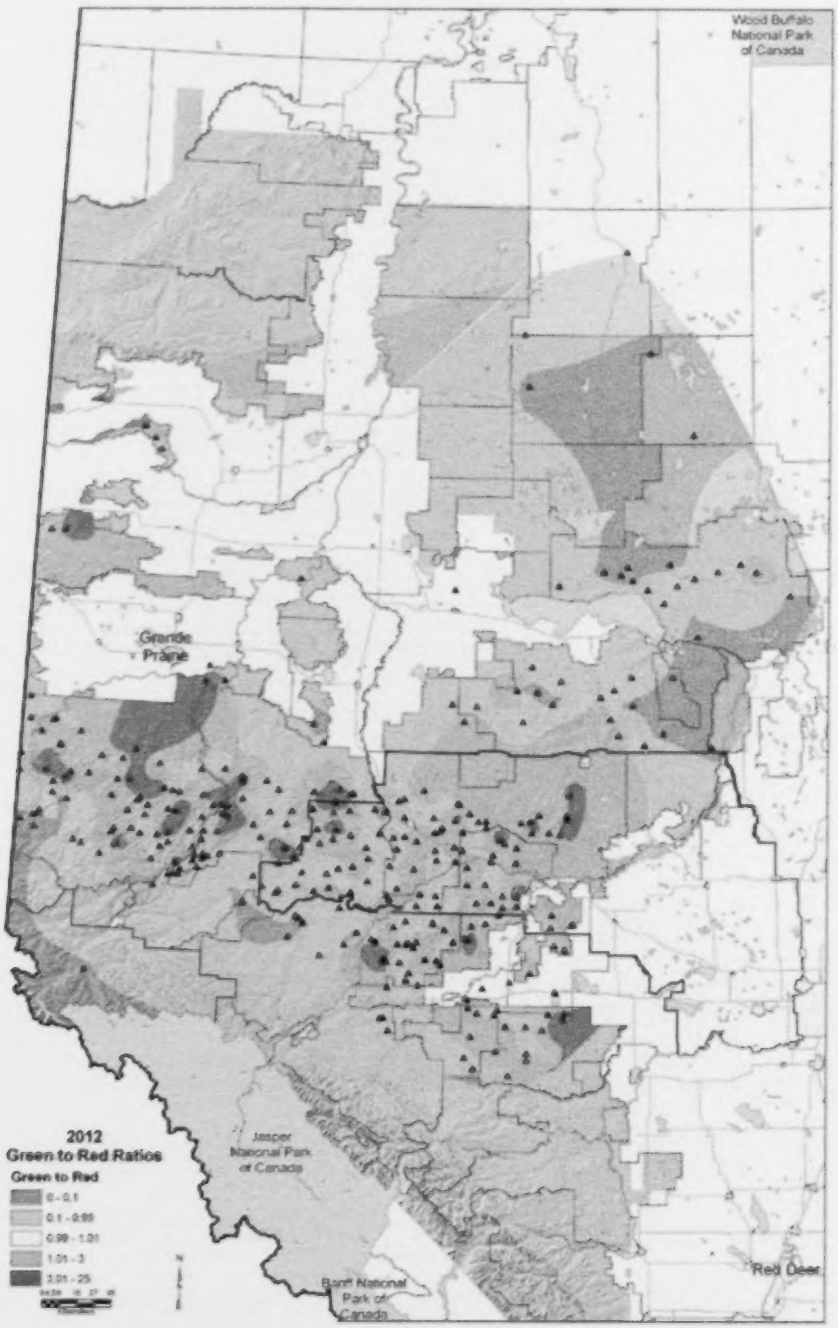


Figure 4. Green:red ratio results from 2012.

Figure 5. MPB management zones in Alberta in the 2012 beetle year.

The MPB-infested trees were treated by:

- Level 1 single-tree control by ESRD
- Single tree control by municipalities under an ESRD grant program
- ESRD Modified Level 1 control

Level 1 Single-Tree Control

ESRD awarded contracts to companies to conduct Level 1 tree control. Under this control program 96,511 MPB-infested pines were removed. Since 2006 a total of 1,053,813 trees have been controlled. Figure 6 shows the extent of pine stands in Alberta that have been affected by MPB since 2006. This figure does not indicate current range but shows the cumulative effect of MPB on Alberta pine stands.

Single Tree Control by Municipalities

ESRD administers a Municipal Grant Program that provides funding support for municipalities in the leading zone to conduct MPB management activities. During the 2011 beetle-year, three municipalities removed 49 MPB-infested pines under the ESRD grant program. The municipalities involved in this program were the Town of Whitecourt, Woodlands County and Yellowhead County.

MPB Municipal Grant Program

ESRD administers a Municipal Grant Program that provides funding support for municipalities in the Leading Edge zone to conduct MPB management activities. During the 2012 beetle-year, three municipalities removed 93 beetle infested trees which is double the number removed in 2011. The municipalities involved in this program were the Town of Whitecourt, Woodlands County and Yellowhead County.

Figure 6. Cumulative presence of MPB attack on pine stands in Alberta since 2006.

ESRD Modified Level 1 Control

A modified Level 1 control program was carried out over the Peace Region in 2013. Areas heavily infested with MPB were demarcated and all the pine trees within the marked areas were mechanically felled and burned on site. Altogether 350 hectares were treated by this method under three contracts. This tactic was economical but it has limited applicability making it usable only under specific circumstances.

Forecasting Population Trends

r-values

The r-value is a measure of the relative success of an MPB population. It measures the number of beetles attacking a tree versus the number of beetles that successfully develop and emerge from that tree to attack new trees.The projections for relative success of MPB populations, based on r-values calculated using the 2013 spring survey data, are shown in Figure 7.

Figure 7 shows the projections for extremely successful beetle populations in red and those of highly successful beetle populations in orange. Both of these categories indicate increasing beetle populations. The projections for static MPB populations are shown in yellow and the projections for decreasing beetle populations are shown in blue. Based on r-values, the beetles in 2013 were more successful (Figure 7), compared to the beetles in 2012 (Figure 8).

R-value samples
(Anon., ESRD)

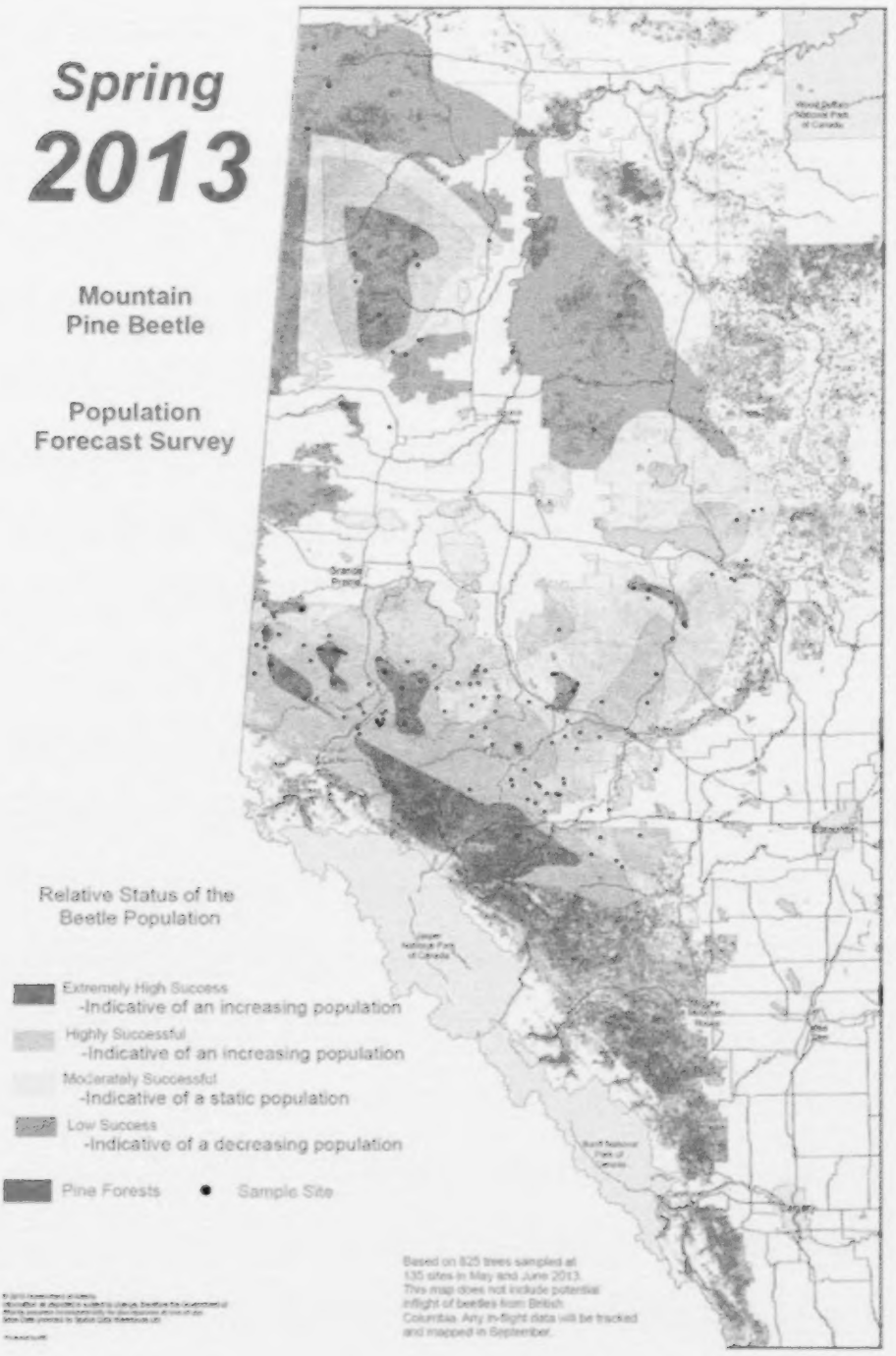


Figure 7. Projections on relative success of MPB populations in 2013, based on the r-values calculated using 2013 spring survey data.

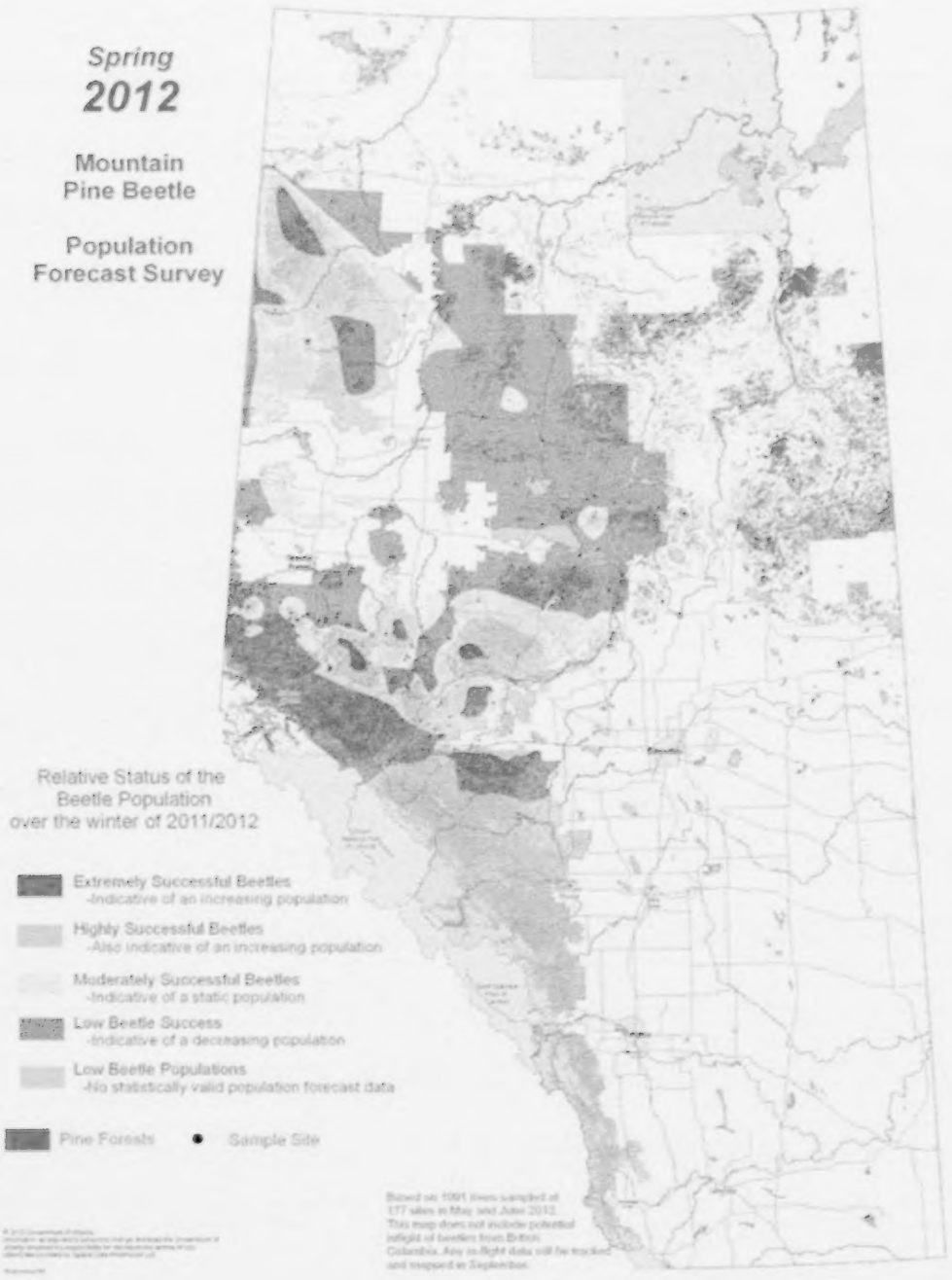


Figure 8. Projections on relative success of MPB populations in 2012, based on the r-values calculated using 2012 spring survey data.

FRIAA aerial seed collection.

Mountain Pine Beetle (MPB) Reforestation Seed Inventory Enhancement Program

The MPB Reforestation Seed Inventory Enhancement Program was established in 2007 as a method to enhance seed supply for areas identified as high risk for MPB infestation. Collections were targeted at seed zones with insufficient seed supply. This program is carried out by the Mountain Pine Beetle Program Grant Agreement between Forest Resource Improvement Association of Alberta (FRIAA) and Environment and Sustainable Resource Development (ESRD) as well as targeted collections by Alberta Tree Improvement and Seed Centre (ATISC) seed collection contracts.

The Mountain Pine Beetle Program Grant Agreement was designed to fund wild seed collections (Stream 1 seed) through FRIAA but also has provisions for proposals to make non capital expansions to pine seed orchards to further enhance genetically improved seed (Stream 2) reforestation seed supply. Since 2007 this program has collected 3,687 kg of lodgepole pine seed, representing 100 seedlot collections from 19 seed zones.

ATISC MPB Stream 1 Operational Reforestation collections started in 2008/2009. ATISC chooses collection sites with low lodgepole pine seed supply, low probability for collection by industry and high MPB attack risk. ESRD then contracts out seed collections for the identified areas. ATISC contract ground and aerial collections have been made from 15 different seed zones collecting 1,900 kg of seed.

Tamarack stand level fading caused by eastern larch beetle.

Eastern Larch Beetle, *Dendroctonus simplex*

Eastern larch beetle was identified and mapped in the Red Deer/North Saskatchewan Region in eleven tamarack stands west of Drayton Valley. Approximately 45 hectares of grey and fading tamarack were mapped. Based on the condition of the grey trees it is estimated the beetles have been present for three to four years.

Conifer Defoliators

Spruce Budworms

Eastern Spruce Budworm, *Choristoneura fumiferana*

Historical

The eastern spruce budworm is a native defoliator that has co-evolved with white spruce and balsam fir. Over the last 50+ years, budworm infestations in the province have occurred mainly in river valleys of northern Alberta. Spruce budworm infestations that occurred in southern Alberta during this period have been rare. Figure 9 is a composite map showing the spatial distribution and extent of eastern spruce budworm outbreaks in Alberta between 1950 and 2004.

Detection and Assessment

Forest Health and Adaptation staff annually carry out overview aerial surveys to detect and assess spruce budworm defoliated stands on forested Crown land. The goals of this program are:

- To keep a historical record of these infestations, and
- To assess the need to take management actions if spruce budworm infestations could compromise the land management objectives.

Figure 9. Eastern spruce budworm defoliated areas recorded in Alberta, 1950-2004. (Data courtesy of Canadian Forest Service, Northern Forestry Centre).

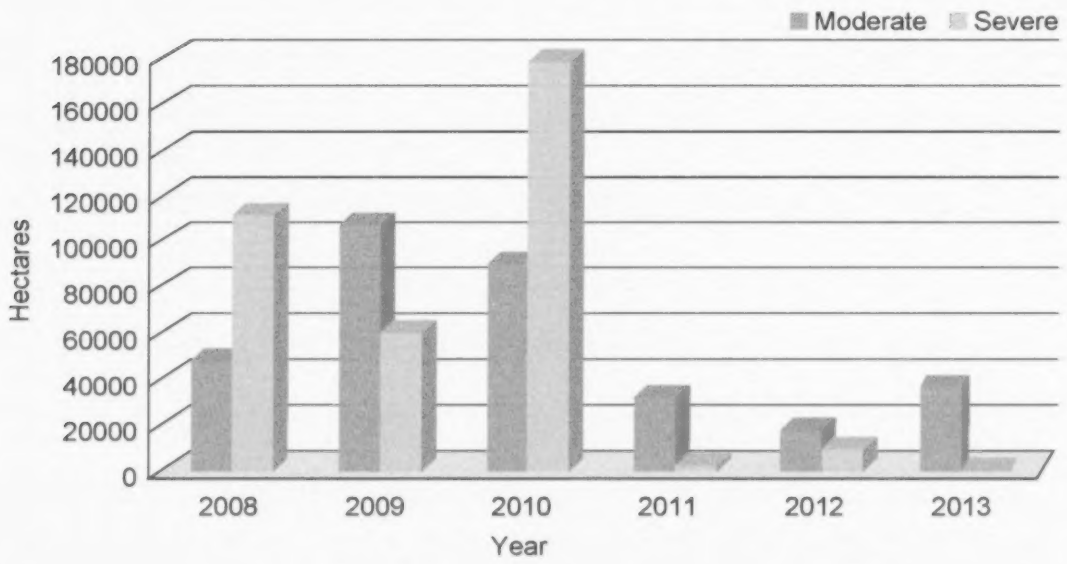


Figure 10. The amount and severity of spruce budworm defoliation in aerially surveyed areas of Alberta, 2008 – 2013.

Figure 10 shows the amount and severity of spruce budworm defoliations in Alberta, 2008-2013.

Figure 11 shows the results of the 2013 overview aerial surveys carried out to detect and assess spruce budworm infestations. In 2013, aerially visible budworm defoliation was confined in the Lower Athabasca and the Lower Peace Regions in northern Alberta.

In 2013, aerially visible spruce budworm defoliation in Alberta covered an estimated net area of 37,196 hectares all of which was moderately defoliated (Table 1). Compared to the budworm-defoliated area in the province in 2012, there was a 30.4 per cent increase in the budworm-defoliated area in 2013.

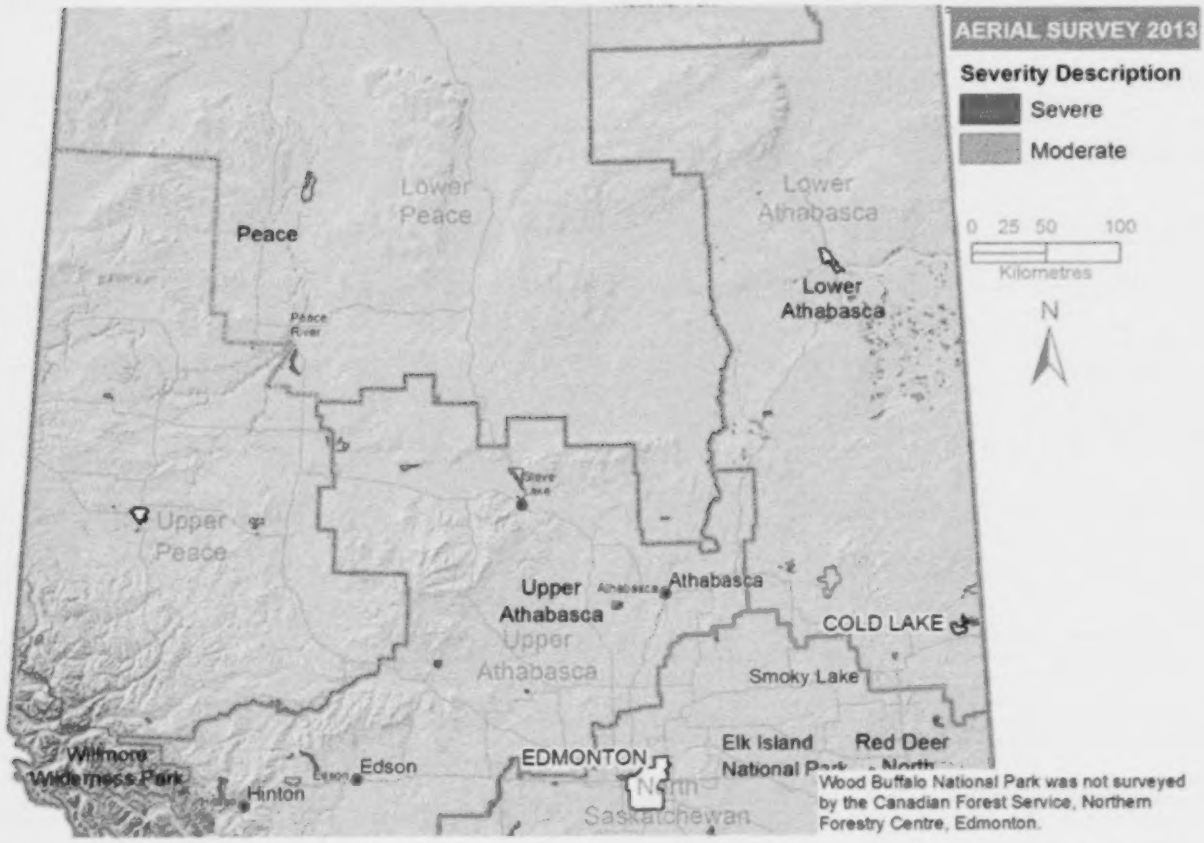


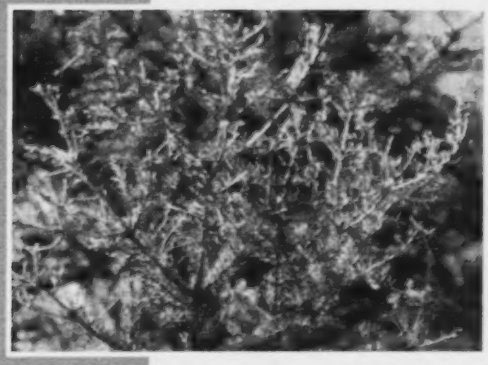
Figure 11. Spatial distribution of aerially visible spruce budworm defoliation over forested Crown land surveyed in 2013 in Alberta.

Table 1. The extent (hectares) of spruce budworm defoliation recorded under each severity category during overview aerial surveys carried out in Alberta in 2012 vs. 2013

Severity Category[2]	2012	2013	Change[1]
Moderate	18,157	37,196	105 per cent
Severe	10,373	0	-100 per cent
Total	28,530	37,196	30.4 per cent

[1] per cent change compared to 2012 figures

[2] moderate = under 70 per cent of new foliage defoliated; severe = over 70 per cent of new foliage defoliated



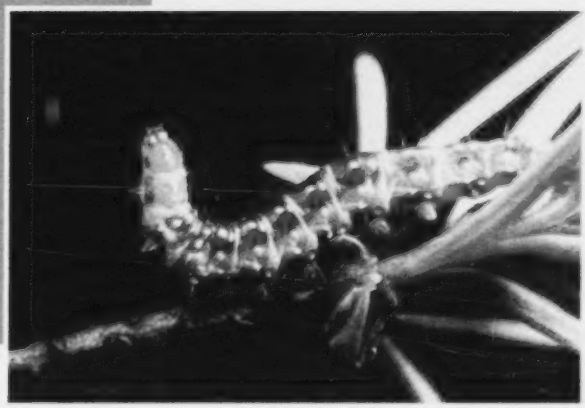
White spruce branch severely defoliated by the spruce budworm

Table 2 shows a comparison of 2013 spruce budworm defoliation in the corporate regions by severity categories. Only moderated budworm defoliation was detected across regions. In the Lower Athabasca Region, budworms defoliated an estimated net area of 36,360 hectares. In the Lower Peace Region, budworms defoliated an estimated net area of 229 hectares. In the Upper Athabasca Region 602 hectares were defoliated with only 5 hectares defoliated in the Upper Peace Region.

Table 2. The extent (hectares) of spruce budworm defoliation recorded under each severity category in the corporate regions of Alberta in 2013.

	Extent of Defoliation		
Region	**Moderate**	**Severe**	**Total**
Lower Athabasca	36,360	0	36,360
Lower Peace	229	0	229
Upper Athabasca	602	0	602
Upper Peace	5	0	5
Total	**37,196**	**0**	**37,196**

Western spruce budworm



Western Spruce Budworm, *Choristoneura occidentalis*

The western spruce budworm populations in southern Alberta collapsed in 2012. No aerially visible defoliation caused by this pest was observed over the areas previously affected by this pest.

Abbott's sawfly larvae.

Other Conifer Defoliators

Abbott's Sawfly, *Neodiprion abbotii*

In July 2013 a report was made by a private citizen in the Peace Region that defoliation was occurring on young pine trees in their yard. Caroline Whitehouse, Forest Health Officer from Peace River, determined that the agent was Abbott's Sawfly, *Neodiprion abbotii*. On investigation she found that one of the young pines was almost completely defoliated. A survey was completed in the adjacent areas and no attacks were found. It was determined to be an isolated incident.

Pine False Webworm, *Acantholyda erythrocephala*

Forest Health Officer from Athabasca was contacted by the Municipality of Wood Buffalo on July 10, 2013 for advice on pine false webworm. The municipality had purchased Ponderosa pines from a nursery in Edmonton to place in boulevards in Fort McMurray and after inspection discovered that they were infested with pine false webworm.

The Forest Health and Adaptation staff traveled to Fort McMurray on July 12 and agreed on the finding of pine false webworm. Upon recommendation from ESRD the municipality burned all infected trees including some adjacent Swiss stone pine that had become infected. Monitoring of adjacent trees and the area of contamination will occur next year to isolate the infestation.

Pine false webworm larvae.

Webbing and defoliation symptomatic of pine false webworm feeding.

Broadleaf Defoliators

Aspen Defoliators

Detection and Assessment

Annually, Forest Health Officers and/or technicians carry out overview aerial surveys to record the gross area over which aspen defoliation caused by forest health damaging agents is scattered. They have moved away from severity categories as these categories may not be accurate due to the fact that aerial surveys are done once a year and only capture a snap shot of the growing season. Instead of severity categories defoliation agents have been categorized by agent.

The objective of these surveys is to maintain a historical record of damaging agent-caused aspen defoliation over the Green Area of the province. Such a record would let forest health practitioners follow the long-term trends of aspen defoliation in relation to changes in biological and environmental factors. It will also highlight emergence of innocuous agents as forest health damaging agents. These surveys provide data to assess the impact of these damaging agents and to decide on the need to take control action if their impacts are compromising forest management objectives. These records are used in compiling a national data base on incidence and impact of such pests across Canada.

Aspen twoleaf tier, *Enargia decolor*, larvae.

Figure 12 shows the spatial distribution of aspen defoliator-caused defoliation over the aerially surveyed areas of the Green Area in Alberta. In 2013, the area over which aspen defoliation occurred increased compared to that in 2012. In total, aspen defoliation covered a gross area of 6,215,218 hectares. This is almost a ten-fold increase in the area affected by aspen defoliators in 2012, and from 2011 to 2012 it was a nine-fold increase.

The forest tent caterpillar was the dominant defoliator of aspen in 2013 defoliating 4,015,956 hectares. However, the aspen twoleaf tier had a large role in aspen defoliation in 2013, defoliating 2,118,223 hectares. Other aspen defoliators on the landbase in 2013 included large aspen tortrix and Bruce spanworm. (Table 3)

The majority of aspen defoliation occurred in the Lower Peace, Upper Peace and Lower Athabasca in 2013 (Table 4). All landuse regions saw a multi-fold increase in the amount of aspen defoliation from 2012 to 2013.

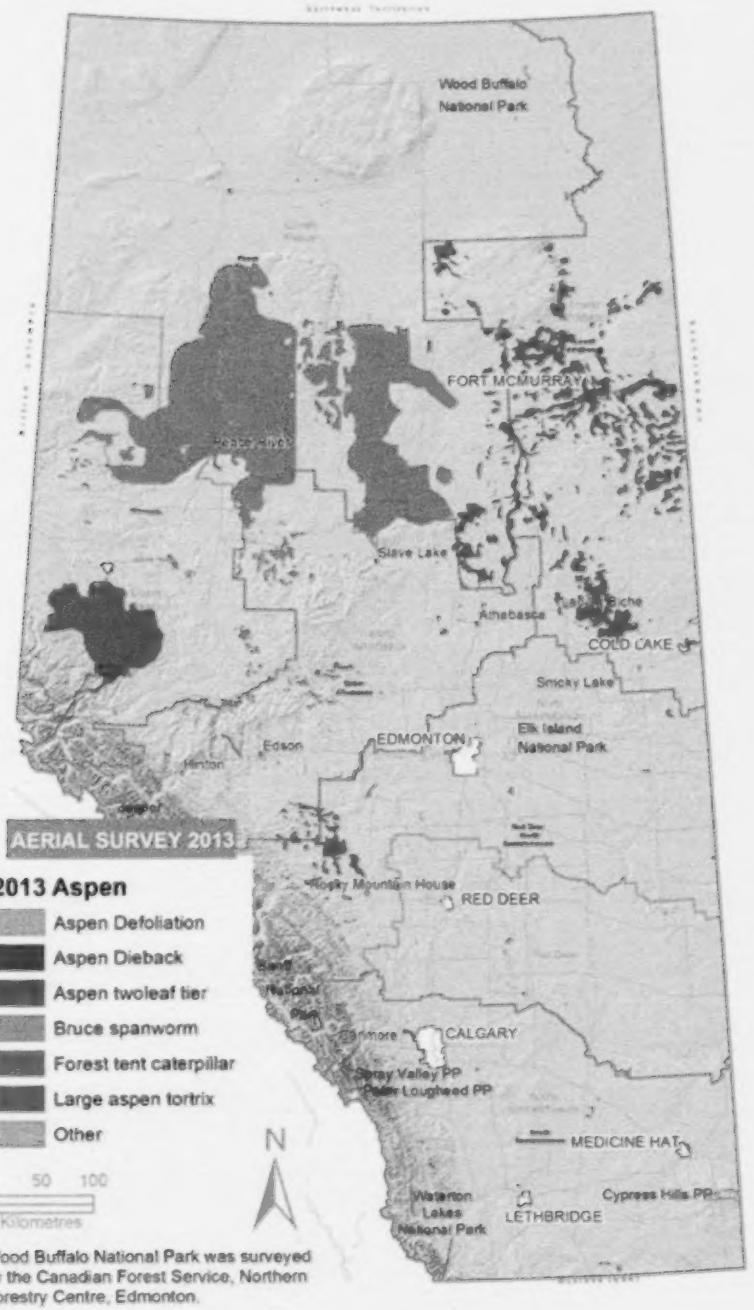


Figure 12. Spatial distribution of aerially visible, forest health damaging agent-caused aspen defoliation and dieback recorded during aerial surveys of the Green Area in Alberta, 2013.

Table 3. The extent (hectares) of aspen defoliation in 2013 by agent in Alberta.

Pest	Total Defoliation
Forest Tent Caterpillar	4,015,956
Large Aspen Tortrix	1,820
Bruce Spanworm	5,061
Aspen Twoleaf Tier	2,118,223
Aspen Dieback	4,695
Aspen Defoliation	68,183
Other	1,278
TOTAL	**629,112**

Table 4. The extent (hectares) of aspen defoliation in the corporate regions of Alberta, 2012 vs. 2013

Region	Total 2012	Total 2013
Lower Peace	338,070	3,374,837
Upper Peace	221,803	1,171,896
Lower Athabasca	17,802	1,230,375
Upper Athabasca	50,932	427,740
North Saskatchewan	43	108,289
South Saskatchewan	462	2,080
TOTAL	**629,112**	**6,215,218**

Distinctive mining pattern of aspen serpentine leafminer seen on aspen foliage.

Other Broadleaf Defoliators

Aspen Serpentine Leafminer, *Phyllocnistis populiella*

Aspen serpentine leafminer was initially observed in mid-June 2013 in the Upper Peace Region. No surveys were conducted but it could be seen along highway 35 north of High Level and was seen during routine field work. It appeared to span a large area in the northern part of the region. This is a minor forest pest and does not result in host death.

Diseases

Red Ring Blight of Pine, *Dothistroma septosporum*

In the summer of 2013, *Dothistrom septosporum* was positively identified at the Alberta Tree Improvement and Seed Centre (ATISC) in Smoky Lake as well as in a pine provenance trial located at Calling Lake. The identification was confirmed by Dr.Tod Ramsfield and Colin Myrholm with the Canadian Forest Service.

Due to the high value of the pine clone bank at ATISC and the severity of the infection, a management strategy was implemented to reduce loss of genetic material. A survey was conducted to determine the extent and severity of the infection. The survey indicated that of the 1165 trees in the clone bank, 2 per cent were killed by Dothistroma, 60 per cent had less than 90 per cent of their crown left and 40 per cent had 90-100 per cent of their crown intact. This defoliation had been occurring for the past 3 years.

ATISC Pine Clone Bank infected with Dothistroma spring 2013.

To reduce inoculum potential and further infection, half the ramets (individual trees representing a clone) were removed leaving 500 trees, two individuals per clone. The 500 remaining ramets were sprayed with Bordeaux mixture, a fungicide. One application was completed in May to reduce inoculum potential and another in July to protect fully erupted needles. The success of this program will be monitored through surveys completed in the spring to determine the infection rate of new foliage. To date one clone, X646, has been lost.

Rhabdocline Needle Cast, *Rhabdocline pseudotsugae*

Healthy Douglas-fir flanked by Douglas-fir that are severely affected by *Rhabdocline pseudotsugae*. (Dr.Tod Ramsfield/ Colin Myrholm)

Rhabdocline pseudotsugae is a fungal pathogen of Douglas-fir, *Pseudotsuga menziesii*. R. pseudotsugae is a needlecast that occurs widely in the northwestern United States and British Colombia. This needlecast only affect Douglas-fir and results in chlorotic foliage and very thin open crowns.

It is distinguishable from other needle casts and blights in that it causes an elongated rupture of the needle epidermis. Infection takes place in the new foliage in the spring and identification is easiest in the late spring. Symptoms are often most severe in the lower portion of the tree where air circulation is poor.

In July 2011, *R. pseudostsugae* was identified in the Diamond Hills Genetics Experimental Area near Rocky Mountain House, Alberta during a routine pest survey by Dr.H.F.Cerezke. It was positively identified by Dr. Tod Ramsfield and Colin Myrholm of the Canadian Forest Service on July 4, 2013. Rhabdocline had not previously been described in Alberta.

Other Diseases

Needle Rust of Spruce, *Chrysomyxa ledicola*

Needle rust of spruce, *Chrysomyxa ledicola*, was seen throughout the province in 2013. It results in discolored foliage and upon closer inspection rust colored fruiting bodies can be seen on the needles. Although the infection can be quite severe it rarely causes significant damage and after a severe year the infection rate declines; premature needle loss can occur.

Chrysomyxa ledicola on a white spruce.

Abiotic Damaging Agents

Table 5 shows the amount of visible damage caused by various abiotic agents over the Green Area as recorded during the overview aerial surveys in 2011, 2012 and 2013. Overall, the total area affected by various abiotic agents in 2013 was less than that reported in 2012 or 2011. Damage caused by blowdown and flooding have increased but damage by drought, hail and redbelt has decreased.

Table 5. The extent (hectares) of abiotic damage by agent over the last three years in Alberta.

Year	Abiotic Condition (Ha)				
	Blowdown	**Drought**	**Flooding**	**Hail**	**Redbelt**
2013	1,679	348	970	0	0
2012	1,106	42,239	301	648	819
2011	485	713,929	0	6,377	30,567

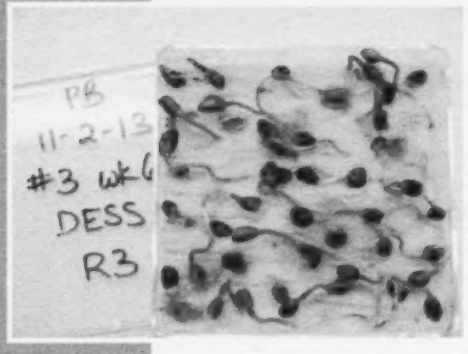
Alberta Tree Improvement and Seed Centre Programs

Seed Science

ATISC has the only non-agricultural seed research lab in the province. In 2013, several studies were completed to further Alberta's knowledge in woody plant seed science. Seed collection, handling and storage methods were improved along with stratification and germination methods for tree species in Alberta.

During 2013, overall seed storage methods were improved. Long term storage requires seed to be dry in order to prolong seed life and containers must prevent moisture ingress. It was determined that the current method of storage in glass and plastic bottles was not meeting these standards. Several different container types were tested and it was confirmed that laminated foil bags were the best hermetically sealed storage container for ATISC purposes. Over 7000 research and conservation seed lots were transferred to the new containers in 2013.

Across Alberta there were contradictory theories on the 'best' germination treatment for lodgepole and jack pine. Seed from 12 lodgepole, jack and hybrid pine seedlots were germinated with 3 treatments: no cold stratification treatment, 14 days of stratification and 21 days of stratification. The data was statistically analysed and it was determined that the best method was the 21 days of cold stratification for the major pine species in Alberta, as this often increased but never decreased total germination and always increased the rate of germination.



Germinating early harvest, artificially matured limber pine seeds showing desiccation tolerance.

In addition to germination issues, there was also a question of collection and seed storage practices for lodgepole and jack pine. Lodgepole pine cones will often stay closed and attached to the tree for a long time, sometimes more than 10 years. There was no data available on what effect harvesting grey versus 'new' brown cones may have on seed quality. Seeds were artificially aged in the lab and then germinated. Results showed that both partial grey and all grey cones yielded seed that had only half the lifespan of cones that were all brown and 'new'. This gives Forest Health and Adaptation a valid reason for not harvesting grey cones in the future or separating these from the newer cones for long-term seed storage.

Black spruce cones are semi-serotenous, meaning that usually the cones don't open to release seed when dried. To extract seeds from closed black spruce cones, the cones are soaked in hot water and then kilned and tumbled to let the seed fall out. This is usually repeated up to three times to get all the seed. For the last 20 years or so, extractions have been combined into

one seed lot for storage. There were questions about how this soaking and heating affected the quality of the seedlot. Black spruce seeds from each extraction step were extracted and then artificially aged in the lab and germinated. The results showed that the lifespan of the seeds decreased with each extraction, so that by the fourth extraction (soaked and baked three times) they had only half the lifespan of the first extraction (not soaked/baked at all). Because in general, black spruce seed germination begins to decline at an average of 20-30 years in cold storage, halving this could begin to affect our program relatively soon. Therefore, whenever possible ATISC will be keeping extractions separate and trying to use the shortest lived seeds first.

Limber pine is endangered in Alberta, mainly due to white pine blister rust (*Cronartium ribicola*), MPB (*Dendroctonus ponderosae*) and limited natural regeneration. Alberta has initiated a limber pine conservation program, including the collection and storage of seed from threatened and putatively resistant trees for screening and outplanting. Successful seed storage and seedling propagation requires high quality mature seed. In practice, pine seeds with embryos occupying >90 per cent of the corrosion cavity have been considered mature but this has never been sufficiently tested. It is also difficult to achieve these embryo lengths in limber pine due to short growing seasons and the need to collect early to avoid seed predation and early snowfall at high elevations. Limber pine germination methods were recently perfected in 2012 at ATISC to achieve 90 per cent germination of filled seed, which now allows quality monitoring. In 2012, cones from two sites in Alberta were harvested throughout the season and also 'artificially matured' in the lab. In 2013, embryo lengths, seed dormancy, desiccation tolerance and longevity were tested. Results showed that limber pine seeds are relatively short-lived and that only seeds harvested in late October were at maximum maturity and therefore achieved maximum germination and longevity. Embryo lengths were found to be unreliable for field assessment before collection and will no longer be used as a definitive maturity marker. Further testing may allow the use of growing degree days in the future.

Seed Collections

In 2013 the Alberta Tree Improvement and Seed Centre had a record spruce cone crop. Table 6 outlines the amount of seed added to the ESRD inventory under different programs and for different species both wild and orchard.

Table 6. Weight of seed collected by seed collection type in 2013.

Seed Collection Type	Weight of Seed (kg)
FRIAA MPB Rehab lodgepole pine wild seed collections	936
FRIAA MPB Rehab white spruce wild seed collections	245
Contract MPB wild pine seed collections (Pl, Px and Pj)	560
ESRD MPB wild pine seed collections (Pl, Px and Pj)	6
ESRD owned CPP program orchard seed collections (Sw, Sb, Fd, Lw)	440
ESRD partnership CPP program orchard seed collection shares (D-Sw, G2-Sw, E1-Sw, C-Pl, K1-Pl, J-Pl, P1-Pj)	144

Cone picking in the orchards at the Alberta Tree Improvement and Seed Centre.

In 2013, 282 new seedlots, representing 42 different species, were received at ATISC for registration and storage. With the booming oil and gas industry, reclamation species are in high demand and 115 collections were made from 32 shrub, grass or forbs species for a total of 16 kg of seed. Seed collection of tree species still exceeds that for shrubs and forbs with 167 new collections adding 3,005 kg to the provincial inventory.

Seed withdrawals over the course of the year saw 729 kg of tree seed shipped to nurseries for production to meet orders for over 90 million seedlings. As well, 16 kg of seed for species other than trees were withdrawn for production of about 375,000 seedlings.

The NAIT Boreal Research Institute in Peace River and Yellow Point Propagation in Ladysmith, BC were reviewed and approved for processing Alberta seedlots in 2013. Similarly, the BC Tree Seed Centre in Surrey was reviewed and approved for testing Alberta lots.

Tree Improvement Trials

Five tree improvement trials were established in 2013. Three Region L3 black spruce progeny trials, one white spruce embryogenesis trial and an endangered white bark and limber pine experimental graft trial. The black spruce trials were planted in Calling Lake, Kinosis Lake and Firebag River, total trees planted between these three sites was 6,000. The embryogenesis white spruce trial was established in Wandering River where 206 trees were planted and the endangered species trial was established at ATISC, Smoky Lake, with 153 grafts.

Progeny trials are established to determine which mother trees result in the best overall offspring. Embryogenesis trials are being established to find ways of enhancing production of selected families or rare seed.

Plant Propagation

Two thousand seven hundred white spruce, lodgepole pine, jack pine, Douglas fir and western larch rootstock were sown in 2013 for grafting in 2015. The majority will be used as rootstock for grafting material lost due to MPB and Dothistroma. Six hundred pine and spruce were seeded for reforestation planting in the Cypress Hills Interprovincial Park.

Whitecourt Mountain Experimental Area which is an established genetic trial.

Eight hundred grafts were completed in 2013. Thirty six Englemann spruce selections from the wild were completed and successfully grafted; no clones were lost. Sixteen new clone selections were also successfully grafted for Region C lodgepole pine program.

Scions were collected from Dothistroma infected trees in the ATISC clone bank for regrafting; however the grafting process failed. To improve success in 2014 grafts will be kept in heel-in beds in hopes that this will be more successful. Normally grafts are kept in the greenhouse where conditions can be controlled but the Dothistroma grafts were infected which made it risky to grow them in the greenhouse where the disease could potentially spread to uninfected stock. Weekend scions may also have contributed to grafting failure.

Invasive Plant Species Program

Ox-eye daisy

Introduction

This program covers invasive plant species detection, surveys and management in the Crown land portion of the Green Area of the province. Relatively large areas with either noxious or prohibited noxious invasive plants growing on Crown land are the main focus of this program. However, early detection and rapid response are integral for prompt mitigation of new or low-level invasive plant infestations found either on high value sites or on vacant crown land.

The overall objectives of this program are to:

- carry out surveys to detect and estimate the extent of noxious or prohibited noxious invasive plant species at selected sites in the Green Area of the province;
- manage invasive plants on ESRD occupied sites and on vacant Crown land, as required by the *Weed Control Act*;
- initialize and/or continue localized weed cooperative projects with high probability of success over designated high value areas;
- detect early and take rapid response to manage invasive plants that occur at relatively low levels and/or new infestations either on vacant land or on high value sites; and,
- continue ongoing education and increased awareness initiatives.

Invasive Plant Detection and Distribution Surveys

Table 7 contains a list of invasive plant species that were observed during ground surveys carried out at selected sites in the Green Area in 2013. The survey sites included ESRD facilities such as cabins, campgrounds, wildfire bases and staging areas, and wildfire lookout tower sites as well as vacant Crown Land, such as random camp sites, abandoned forestry roads and quad trails.

Yellow devil hawkweed

Figures 30-32 show occurrences of species of concern within the Crown Green Area monitored in 2013. These species are chosen for display as their distribution is limited and therefore more accurately portrayed. As well, these species are invasive and pose a risk if they were to expand their range. They are also the target of many of our management efforts. These surveys did not systematically cover the entire Green Area of Alberta but data is indicative of actual or likely distribution.

Infestations of hawkweed some of which are prohibited noxious in the Upper Athabasca and South Saskatchewan Regions continue to be problematic. Yellow devil hawkweed, an un-regulated, non-native hawkweed, has been found in the area of the 2003 Lost Creek fire. This 3,062 hectare patch exceeds all practical control methods for eradication. Further hawkweed related management information is discussed in detail in the Invasive Plant Management section. Within the surveyed areas, tall buttercup, Canada thistle, perennial sow-thistle, common tansy, scentless chamomile and ox-eye daisy were found throughout Alberta's Green Area in 2013 but inventory for these species are impossible to show quantitatively due to their prevalence.

Wild caraway flower

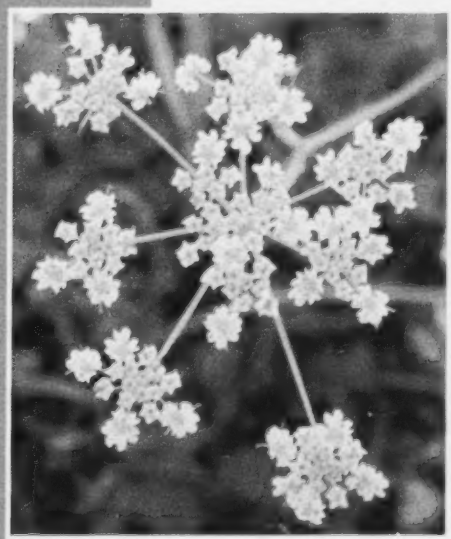


Table 7. Invasive plant species observed during ground surveys carried out over selected sites in the Green Area of Alberta in 2013

Common Name	Scientific Name	Occurrence[1]
Black henbane	*Hyoscyamus niger* L.	1
Blueweed	*Echium vulgare* L.	1, 3
Burdock	*Arctium sp.*	1
Canada thistle	*Cirsium arvense* (L.) Scop.	All
Common mullein	*Verbascum thapsus* L.	1
Common tansy	*Tanacetum vulgare* L.	All
Common toadflax	*Linaria vulgaris* Hill.	1, 3
Creeping bellpower	*Campanula rapanculoides* L.	1, 5
Dalmatian toadflax	*L. dalmatica* L.	1
Field scabious	*Knautia arvensis* (L.) Duby	1
Hound's tongue	*Cynogllossum officinale* L.	1, 2
Leafy surge	*Euphorbia esula* L.	2, 3
Meadow hawkweed[2]	*Hierarcium caespitoum* Dumort.	1, 3, 5
Mouse-ear hawkweed[2]	*Hieracium pilosella*	3
Orange hawkweed[2]	*Hieracium aurantiacum* (L.)	1, 2, 3, 5
Ox-eye daisy	*Chrysanthemum leucanthemum* L.	All
Perennial sow-thistle	*Sonchus arvensis* L.	All
Scentless chamomile	*Matricaria perforata* Merat.	All
Spotted knapweed[2]	*Centaurea maculosa* Lam.	1
St John's wort[2]	*Hypericum perforatum*	1
Tall buttercup	*Rananculus acris* L.	1, 2, 3, 5
Tall hawkweed	*Hieracium piloselloides* Vill	1, 3
White cockle	*Lychnis alba* Mill	1, 2
Wild caraway	*Carum carvi* (L.)	1, 2, 3
Yellow devil hawkweed	*Hieracium glomeratum* L.	1

[1] LUF Region: 1. South Saskatchewan 2. North Saskatchewan 3. Upper Athabasca 4. Lower Athabasca 5. Upper Peace 6. Lower Peace

[2] Prohibited noxious weeds

Figure 13. Distribution of hawkweed species at selected survey sites in the Green Area of Alberta in 2013.

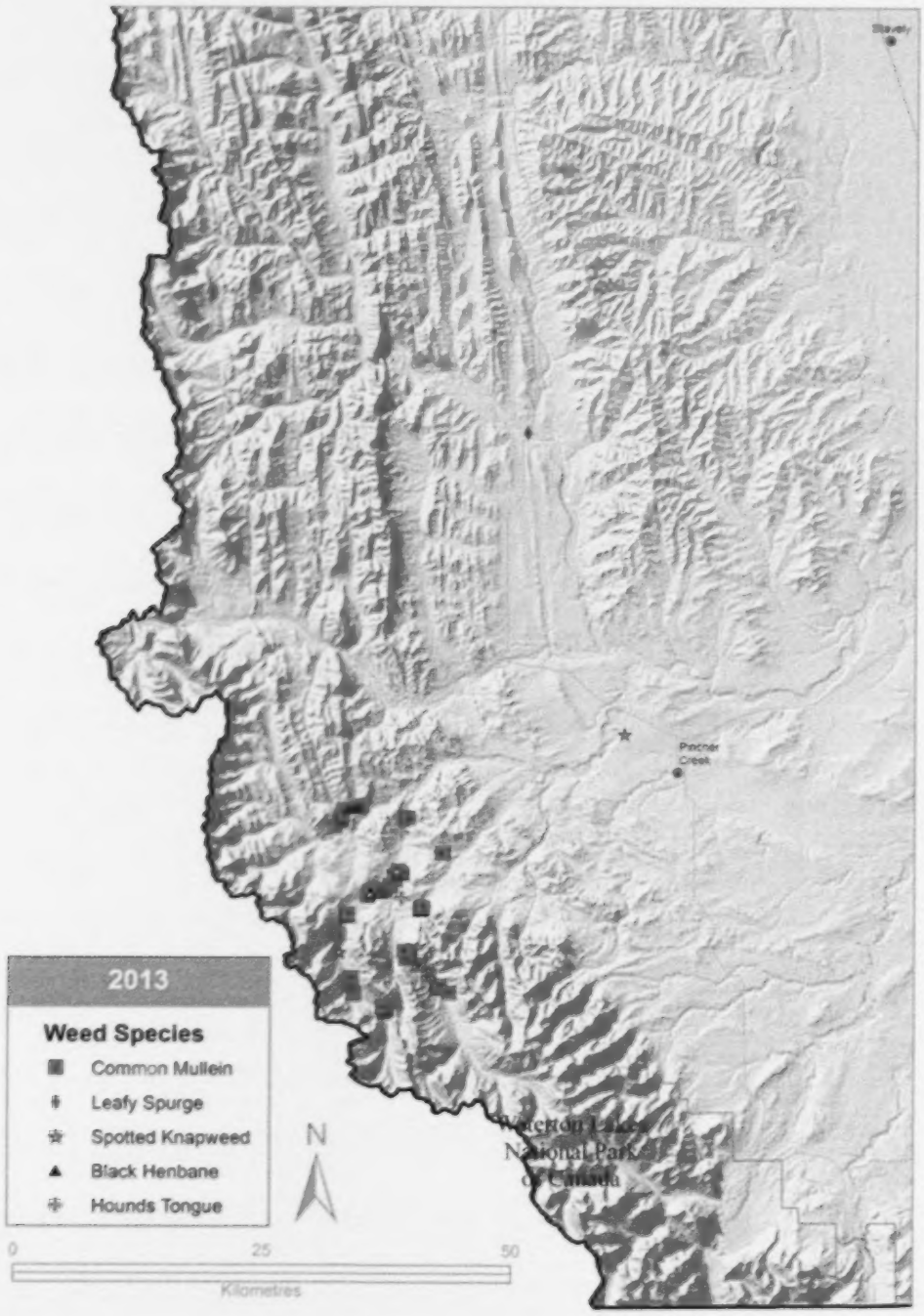


Figure 14. Distribution of invasive species of low prevalence at selected survey sites in the Green Area of Alberta in 2013.

Figure 15. Distribution of Wild Caraway at selected survey sites in the Green Area of Alberta in 2013.

Invasive Plant Management

In 2013, ESRD in conjunction with municipalities and industry partners carried out several projects to manage invasive plant species in the Green Area.

In the southern portion of the province June was wet and cool with significant flooding at the end of the month. Once the rain stopped many roads were closed to repair flood damage and this delayed invasive plant survey and control for a couple of weeks. For most of the province, the balance of summer was very conducive to plant growth with warm days and high precipitation. Generally, invasive plant populations were particularly abundant this year. Invasive hawkweed populations were noticeably denser and infestations have spread in the South Saskatchewan Region, specifically in the vicinity of Crowsnest Pass in the SSR and in the Hinton/Edson and Grande Cache area within the Upper Athabasca Region. In addition to the hawkweeds, 'traditional' invader populations followed the same trends.

A new provincial invasive plant data collection system was initiated this year. This program was used on laptop computers and Trimble® units with plans to utilize tablet units this coming season. This new program proved to be user friendly and helped collect data consistently. Further refinements are upcoming but we anticipate that with some small changes to the program and better data collection training with the Alberta Provincial invasive plant form, the program should run more smoothly for the following seasons and can be utilized by contractors as well as staff.

Wild caraway within the North Saskatchewan Region continues to appear in new locations every year and remains a challenge to keep up with. Control and spray efforts there are currently targeting caraway. The first priority for ESRD in the North Saskatchewan Region this year was the control of the pocket infestations of orange hawkweed – a Prohibited Noxious listed invasive plant. This area was surveyed and treated by a contractor last season and was found to be largely controlled.

In the Grande Prairie area of the Upper Peace Region, tower sites, warehouses, wild fire bases, gravel pits and specific areas of vacant Crown land were surveyed for invasive plants. On the majority of the sites surveyed, few invasive plants were found and allowed for hand pulling by the surveyors. On other sites where the infestation was more pronounced or contained species difficult to handpull, ESRD crews used herbicides for control. Orange hawkweed (prohibited noxious) was found in a small number of sites and is being monitored closely.

This year the South Saskatchewan Regional Invasive Plants Program focused its resources almost entirely on areas south of Highway 3, near the Crowsnest Pass. With increased concern over the newly introduced hawkweed species, survey (baseline inventory) and control contracts were administered by ESRD for hawkweed control south of highway 3. There was increased funding available to Forest Health and Adaptation staff in the

South Saskatchewan Region for this past season to conduct these activities based on the rapid increase in invasive hawkweed distribution and density in 2012 and their known invasive properties. ESRD maintained its traditional Memorandum of Understandings (MOU) with the MDs of Ranchland and Crowsnest Pass. Funding from these MOUs were also used to manage invasive hawkweed populations north and south of Highway 3.

Yellow devil hawkweed Infestation near Lost Creek. Photo taken in early July, 2013.

Based on surveys conducted it appears that the invasive hawkweeds have spread extremely fast in a very short period of time. Yellow devil hawkweed in particular, is dispersed throughout the entire Forest Reserve south of highway 3. Densities are increasing relative to distance from the Lost Creek fire. Inside the Lost Creek fire invasive hawkweeds density increases and takes over with density estimates above 25 per cent ground coverage.

Within the South Saskatchewan Region, there is an estimated 3,062 hectares of invasive hawkweeds (Figure 30) in polygons and approximately 60 km of infested trails of varying density. This is predominately yellow devil hawkweed with interspersed meadow hawkweed and tall hawkweed. The similarities between the species make identification challenging. The total could be much higher as the possible area of distribution is extremely widespread. Control efforts were focused on the linear disturbances (generally quad trails) in the perimeter of the large infestation to limit spread. Herbicide spraying of invasive hawkweeds in the SSR took place in July and August using contract sprayers. Areas sprayed will be assessed again in 2014 to ensure success.

Hawkweed presence is also increasing in the Hinton/Edson and Grande Cache area within the Upper Athabasca Region. Most of the management activities took place in the Hinton area. Tall and meadow were first found in 2011 but have been found to be spreading quickly. Sporadic hawkweed infestations are found from Cadomin and Cynthia to the south up to Grande Cache to the north. One of the greatest concerns is that the infestation finds its way into the vast open areas of reclaimed land on mine property, making its way into mountain valleys towards Jasper National Park.

Herbicide operations

Numerous patches of invasive plants, predominately hawkweeds, in the Upper Athabasca Region were sprayed with herbicides in 2013. These areas included 0.4 hectares of ESRD facilities and 13.3 hectares of vacant Crown land.

Within the Lower Athabasca Region, ESRD lookout towers and other facilities were inspected for invasive plants. Herbicide control was conducted on those found. The successional project, i.e., planting willow stakes and plugs to combat scentless chamomile in the Amadou Lake area in the LAR, was evaluated and fill planting was conducted with poplar whips with the assistance of Alberta Pacific personnel. The willow plugs showed the best establishment and monitoring in subsequent years will determine whether this is a long-term technique to manage invasive plants in forested areas.

Mechanical control by hand pulling was also used to manage invasive plants on vacant Crown lands and on ESRD sites such as wildfire lookouts, wildfire bases, warehouse compounds, and a fuel-cache site throughout the province. In 2013, in addition to Forest Health and Adaptation staff, hand picking was done by contractors, Castle Crown Wilderness Coalition in the West Castle wetlands, and by oil and gas companies such as Husky Energy staff who pulled upwards of 500 bags of scentless chamomile from a newly constructed road system they constructed.

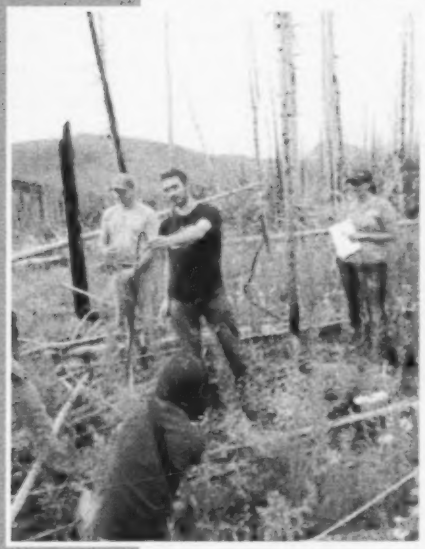
Invasive Plant Co-operatives

In the North Saskatchewan Region, two co-operative spray projects were completed by a co-op involving Clearwater County, one forest company, one private landowner and three oil and gas companies; these cooperative projects achieved effective weed control in the Clearwater Area. In the Lower Athabasca Region, staff concentrated primarily on finishing up the commitments associated with the Amadou Weed Cooperative. In the Foothills Area of the Upper Athabasca Region, the Yellowhead Invasive Plants Initiative focused on the new hawkweed infestations. The main partners; ESRD, Yellowhead County and Hinton West Fraser worked together again this year to achieve common goals. While many of the sites this year were found to be clean, especially in the Brule Sand Dunes area, herbicide control was needed on some infestations. Approximately 20% of ESRD's Upper Athabasca Region control efforts and the majority of the partner's control efforts were found in the YIPI area of cooperation. In the Southern Saskatchewan Region, ESRD maintains a Memorandums of Understanding with the Municipal District of Crowsnest Pass and the Municipal District of Ranchlands to facilitate efficient and effective invasive plant control.

Biocontrol

The overall goal of biocontrol is to reduce the size and density of invasive plant infestations for which conventional methods of Invasive Plant control are not feasible (size, access, riparian area, no registered herbicide, cost, etc). In 2013, a small program was begun in coordination with Agriculture Canada and Dr. Alec McClay to initiate a rearing plan for the unoccupied Green Area. The establishment of rearing or "nurse" sites will ensure a continuing supply of biocontrol agents for re-distribution in the Green Area.

All potential biocontrol release sites will be assessed for suitability characteristics such as: suitability for biocontrol, habitat suitability for biocontrol agent/s, conventional control methods not feasible, protection from disturbance by recreation, establish PNT (Protective Notation) to prevent disturbance from industry.



Hawkweed identification session 2012

Forty common toadflax plants were collected from the Castle area and potted to be used for mass rearing of a larger population of biological agents for release back into a field site in the Castle in 2015. Releases of two biological agents (gall former and a seed feeder) effective in the reduction of scentless chamomile were also completed this past year in the Wandering River area. Monitoring of historic hounds-tongue releases was undertaken this past year using protocols developed in British Columbia. Hounds-tongue populations were observed as greatly reduced in release locations.

Education and Increased Awareness

The annual North Eastern Weed Workshop was held in Athabasca on May 30, 2013. Approximately 130 people were in attendance and the session was, by all accounts, greatly successful in educating the general public and stakeholders to increase their invasive plant awareness.

Among the educational activities held in Upper Athabasca Region that increased invasive plant awareness were: a) a public open house held at Cadomin under the patronage of Yellowhead Invasive Plants Initiative; b) "Pull a Weed Day" in the Brule Sand Dunes; c) a hawkweed open house in Hinton attended by industry representatives, a Commercial Trail Ride licensee, and 10 ESRD/ Tourism, Parks and Recreation staff; and, d) an invasive plants presentation to Tourmaline Oil. Forest health and Adaptation staff ensured invasive plants pamphlets were available in parks and staging areas.

ESRD staff made several presentations to increase weed awareness of wildfire crews, mountain pine beetle crews, forest officers, and junior forest ranger crews. Invasive plant extension materials (pamphlets, posters, identification guides) were made available to the general public at various locations in both the Upper Athabasca Region and North Saskatchewan Region.

For the second year in a row ESRD hosted an invasive hawkweed identification course in the South Saskatchewan Region. The course took place south of the Crowsnest Pass. Parties involved included contractors, municipality staff, ESRD staff and Tourism, Parks and Recreation staff. The course taught how to identify a hawkweed, an invasive hawkweed, and individual species.

Within the South Saskatchewan Region, ESRD also participated in the West Castle Wetlands weed pull and has done so for several consecutive years. Several different agencies participate in this weed pull that is hosted by the Castle Crown Wilderness Coalition and this year ESRD was able to bring extra assistance by providing the services of a wildland fire crew.

Mike Kirby teaching the invasive hawkweed identification course to municipality staff.
Photo courtesy of Kelly Cooley (Coolpro Solutions).

Collaborative Programs

Annual Gypsy Moth Detection Surveys

In 2012, the Forest Health and Adaptation staff of ESRD deployed 55 pheromone-baited Delta traps to detect presence of gypsy moths over the Green Area of Alberta. This was a part of a province-wide annual survey coordinated by the Canadian Food Inspection Agency. No gypsy moths were caught in the traps deployed by the ESRD in 2013.

Monitoring of Climate Impacts on the Productivity and Health of Aspen (CIPHA)

The Forest Health and Adaptation program monitors CIPHA nodes, under a Letter of Agreement signed in 2010 between ESRD and Natural Resource Canada. The CIPHA nodes are located in the provinces from British Columbia to Ontario and in the Northwest Territories. Each node covers three aspen stands; each stand contains two monitoring plots.

The intent of this collaboration is to monitor the nodes located in Alberta, as part of a research project on interactions among climate, forest Insects and diseases, and trembling aspen.

In 2013, the Forest Health and Adaptation staff monitored plots in seven out of the nine nodes in Alberta; three other nodes were monitored by a team from the Northern Forestry Centre of the Canadian Forest Service. The Forest Health and Adaptation staff annually records defoliation, dieback, foliage compliment, and signs and symptoms of pests. The Forest Health and Adaptation staff submitted the collected data to the researchers at the Northern Forestry Centre for analysis. A summary of the analysis by Mike Michaelian with the Canadian Forest Service, Northern Forestry Centre is detailed below:

In 2013, the average annual rate of tree mortality in CIPHA plots dropped to about 3 per cent, which continues a trend established for the last three to four years (Figure 16). Mortality peaked in the mid to late 2000s and lagged behind the 2001-02 drought. The severity of this drought was unprecedented for at least the last 50 years. During the peak of mortality, biomass losses due to mortality were actually greater than the gains due to growth, therefore leading to a net loss of biomass from aspen stands across western Canada. The slow return to "normal" rates of mortality indicates that the effects of future drought are likely to persist long after the drought event itself. Most of the Alberta CIPHA sites followed this pattern of a decrease in mortality following a peak in the mid to late 2000s.

Although there are many factors (biotic and abiotic) and interactions of factors affecting the health of aspen stands, the 2013 CIPHA results demonstrate the importance of both defoliation and drought on stand productivity and mortality. These two factors, more than any other factors, account for the majority of aspen mortality. Luckily Alberta, in recent history, has not experienced drought and defoliation concurrently or consecutively. In the future, Alberta's boreal forest may experience simultaneous or near-simultaneous drought and defoliation, in which case, we could expect much higher mortality and much lower growth.

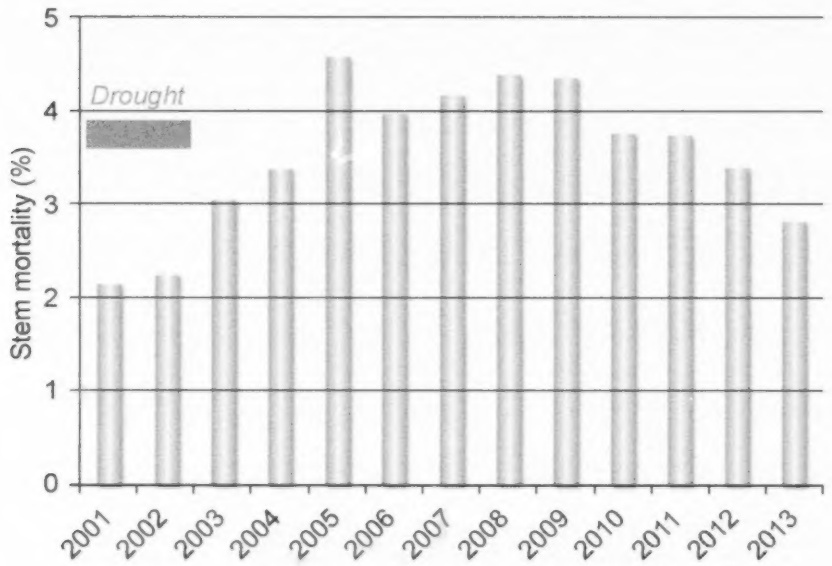


Figure 16. Average aspen mortality (newly dead stems as a percent of last year's living stems) for all CIPHA sites across western Canada. (Mike Michaelian, Canadian Forest Service)

Whitebark and Limber Pine Recovery Plan

In 2013, the Forest Health and Adaptation Program of the Forestry and Emergency Response Division and the Fish and Wildlife Branch of the Policy Division of ESRD continued co-leading a project to develop a recovery plan to protect whitebark pine and limber pine in Alberta. These two species were designated as endangered species under the Alberta *Wildlife Act* in 2009. These five-needle pines are keystone species that play key roles as important nutritive food sources for birds and mammals.

In 2012, a contractor completed operating guidelines pertaining to whitebark and limber pine for the Enhanced Approval Process and survey protocol for detection to accompany the guidelines.

MPB Spread Management Action Collaborative (SMAC) with Saskatchewan Ministry of Environment

In 2013, ESRD and the Saskatchewan Ministry of Environment (SME) continued cooperating under a three-year Memorandum of Agreement (MOA) regarding control and management of MPB infestations of mutual interest. The mission of this MOA is to form a Spread Management Action Collaborative (SMAC) which would support and develop work plans as required by the MOA. Work plans were developed after MPB dispersal monitoring by using baits, aerial surveys, and ground surveys to determine green: red ratios, followed by the running of the Decision Support System. Funding for aerial surveys and photography, ground surveys including use of baits to monitor MPB dispersal, single tree control, and quality inspection carried out under this project were provided jointly by ESRD and SME. This project is led by Dan Lux (Senior Manager, Forest Health and Adaptation) on behalf of ESRD and by Dr. Rory McIntosh (Provincial Forest Entomologist and Forest Pathologist) on behalf of SME.

Cooperative Action with the Terrestrial Environmental Effects Monitoring (TEEM) Program of Wood Buffalo Environmental Association

The Wood Buffalo Environmental Association (WBEA) is a multi-stakeholder, not-for-profit organization that conducts air quality and terrestrial monitoring in the Regional Municipality of Wood Buffalo. ESRD is a member of this organization along with 22 other (industry, federal, NGOs, and First Nations) partners. WBEA operations are funded by the oil sands operators.

WBEA invested considerable time and resources with a science team of some 30 contracted/staff scientists to put in place a forest health approach to forest monitoring, moving towards cause-effect linkage.

In 2012, (with the help of SRD Forest Health Officer Tom Hutchison) annual forest condition surveys were initiated on 15 plots to track condition and pest incidence/severity. During these surveys, tree condition criteria such as: cone production, needle retention, crown condition, and woody tissue damage were assessed on in- plot and off-plot jack pines at each site. In 2013, these assessments were again conducted by staff of ESRD Forest Health and Adaptation, and WBEA.

Increased Awareness and Training

Forest Health Newsletter

In 2013, the Forest Health and Adaptation program published two issues of the "*Bugs and Diseases*" newsletter. The third issue of the "Bugs and Disease" newsletter was completed by the new section, Forest Health and Adaptation, and highlighted the new merger and the activities that take place at the Alberta Tree Improvement and Seed Centre.

Annual Report – Forest Health and Adaptation in Alberta

The 2012 annual report was published in December 2013. This report was Sunil Ranasinghe's last contribution as he retired on December 20, 2013. The 2012 annual report detailed forest health damaging agent conditions and management programs, the invasive plant program, collaborative programs and awareness and training.

Provincial Integrated Forest Pest Management Forum

The Integrated Forest Pest Management Forum was held in April of 2013. Due to the change in client needs, changes were made to this forum for 2014.

Workshop on Armillaria Root Rot

On June 20, 2013 ESRD held a one day workshop on Armillaria root disease. This workshop was part of the annual forest health and adaptation professional development series. This series is open to Government of Alberta employees and forest industry professionals responsible for managing forest health through the development, review, and implementation of forest management and land management plans.

The workshop's primary focus was on Armillaria ostoyae, although other root disease agents were also covered. The one-day workshop consisted of classroom instruction in the morning and an afternoon in the field assessing signs and symptoms of root disease.

Workshop topics included:

- Introductory plant pathology concepts;
- Biology and signs of Armillaria root disease;
- Symptoms of disease;
- Root disease management options;
- Other root diseases in Alberta; and
- Emerging root disease issues in other parts of Canada.

This well-attended workshop was a great success, and positive feedback was received from a number of participants.

Special thanks goes to workshop instructors Tod Ramsfield and Colin Myrholm of the Canadian Forest Service for the time and effort put into the preparation and delivery of the course material.

Seed Conservation Course

Forest Health and Adaptation held a free two day Seed Conservation Course at the Alberta Tree Improvement and Seed Centre. This two day course was aimed at government employees, nursery growers, seed collectors, academics and anyone in industry who handles seed. It covered all orthodox seed and included seed-air moisture relations, seed assessment, collection methods, seed handling, seed longevity and storage, storage behaviour, germination and dormancy.

2013 Stakeholder Survey Results

In 2013 Forest Health and Adaptation conducted stakeholder surveys to identify process gaps, support programs and provide stakeholders with the opportunity to contribute valuable input into the improvement of the Forest Health and Adaptation Program. Three stakeholder groups were surveyed, Industry, Municipalities and Researchers. The findings from these surveys will be used to implement positive change to the Forest Health and Adaptation programs in the following year.

Appendix 1

ESRD regions and corporate areas of Alberta, 2013.